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ABSTRACT

The purpose of this paper is to present two studies, one which questions some previously reported data on phonemic recoding and another which suggests an alternative interpretation for the evidence that Rubenstein and Lewis claimed in support of phonemic recoding. In one experiment three subsets of nonsense words were presented to 35 paid graduate students who were instructed to rate each item for pronunciability on a one to five (easy-hard) scale. Subjects were told that all words were nonsense words but that some would strike them as more difficult to pronounce than others. The subjects recorded whether or not each word was an English word. Significant results were found between the legal and illegal types. In the second experiment 35 subjects rated sets of words for pronounceability and no significant differences were found. When the same subsets of words were presented as a one-word free-association task to 35 different subjects, the results strongly supported the subjects' search for meaning rather than phonemic recoding. (WR)

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Alternative Interpretations of Evidence for Phonemic Recoding in Visual Word Recognition

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Phonemic recoding is one of a few prominent theories put forth to describe what happens when we are asked to recognize words in print. Proposals for such recoding from the visual to a phonological representation are set off sharply from the views of those who would argue for a more direct visual recognition (Bower, 1970: Kolers, 1970). And both theories are accommodated to a degree in still other proposed theories, as for example, the work of LaBerge and Samuels (1974). Meyer, Schvaneveldt and Ruddy (1974) recently have provided an insightful review of the functions of graphemic and phonemic codes in visual word-recognition as well as an explanatory model of their own. The purpose of this paper, however, is to present two studies, one which questions some previously reported data, and, another, which, as the title of this paper has it, suggests an alternative interpretation for the evidence that Rubenstein, Lewis, and Rubenstein (1971) claimed in support of phonemic recoding.

In one experiment, Rubenstein et al (1971) presented three types of nonsense words to 45 paid adult subjects. The nonsense words had been classified as (a) orthographically and phonologically illegal and unpronounceable (likj, sagm); (b) orthographically and phonologically illegal but pronounceable (gratf, lamg); (c) orthographically and phonologically legal (barp, plind). Subjects were seated before the cathode ray tube of an IBM 1800 computer, where, when the item appeared, they were to press a yes-key if they decided what they saw was an English word and a no-key if it was not. Accuracy and latency data were recorded. In part, Rubenstein et al reasoned as follows:

> If phonemic recoding does in fact occur, it seemed reasonable to expect a difference in latency between the two illegal types since the difference in pronunciability would cause some difference in the time for recoding or detection of phonological illegality (1971:647).

Rubenstein et al also hypothesized that if the latency was greater for the legal nonsense types than it was for the illegal nonsense, this difference "would indicate that phonological illegality is detected without an exhaustive search of the internal lexicon (1971:647)." They reported significant results as they expected: mean latencies in msec were 859, 874, and 966 for illegal/unpronounceable, illegal/pronounceable, and legal, respectively. In their words:

> The evidence for phonemic recoding is quite clear in that the difference between the two illegal types is statistically significant. ... As for the roughly 100 msec difference between the legal and illegal types, it is large enough to support the hypothesis that deciding that a word is nonsense when it is orthographically and phonologically illegal does not require the exhaustive search of the internal lexicon required by legal nonsense (Rubenstein et al, 1971:647).

Not fully persuaded by this evidence, particularly when the criterion for distinguishing between the two illegal types of nonsense words--pronunciability--was based solely on evaluation "by agreement among the authors," a direct test for this claim was made to assess the authors' evaluation agreement.

Experiment 1. Three subsets of the Rubenstein et al (1971) nonsense words were presented to 35 paid graduate students who were instructed to rate each item for pronunciability on a 1 - 5 (easy-hard) scale. Subjects were told that all words were nonsense words but that some would nonetheless strike them as more difficult than others to pronounce. Rubenstein et al used 23 illegal/pronounceable items and these were all included; the first 23 items from each of

the other two types (illegal/unpronounceable and legal) also were chosen, making 69 items in all which were presented. The 23 legal items (barp, plind) were expected to be rated largely as easily pronounceable. But, because there didn't intuitively seem to be too much difference in pronunciation between, for example, likej lamg (items which Rubenstein et al had classified respectively as unpronounceable and pronounceable), not much difference was expected in the rating of these two subsets.

The results are found in the group data displayed in Tables A, B, and C in the Appendix. As Table C shows, the legal words tended to cluster in the 1-2-3 range (very-to moderately-easy to pronounce), and these results clearly distinguished them from the other two subsets of words for which the group data on Tables A and B show little difference. That is, both types of nonsense words, distinguished by Rubenstein et al as illegal/unpronounceable and illegal/pronounceable, tended to cluster in the 4-5 range (difficult -to very difficult).

Tables 1 and 2 about here

Tables 1 and 2 present a summary of a one-way analysis of variance with repeated measures. As can be seen, only the difference between either of the illegal types and the legal types was significant, and while this difference was substantial, the difference between the two illegal types did not reach significance. ($F = 272.25$; $df = 2,68$; $p < .001$) Related mean differences which appear in Table 2 were tested for significance with Scheffé tests for multiple comparisons; an alpha level of .01 was adopted. From these results, it would seem, in the least, that the evidence for phonemic recoding cannot be seen to be as "quite that clear,"

given these counter results. As a related effort, a second study was conducted to determine the adequacy of a notion other than phonemic recoding as a source of explanation for the different latencies reported by Rubenstein et al (1971).

Experiment 2. The same three subsets of nonsense items were presented in the same manner as in experiment 1, but to 35 different paid graduate students who also were assigned a different task. Subjects were told that these nonsense words represented meaningful words which had been slightly distorted; their task was to guess what the word was prior to the distortion. The expectation here was that the greater latencies obtained by Rubenstein et al for their legal items (barp, plind) could as adequately be explained by Ss having to sort through more meaningful possibilities as an alternate to their posited phonemic recoding. Moreover, it was believed that the smaller latencies obtained for the two illegal types also could be traceable in both instances to the fewer, that is most likely, available meaningful responses.

With very few exceptions, the group data displayed in Tables D and E in the Appendix illustrate well the lean nature of the type-token relations that we found. For example, the 35 S protocols yielded only two different items in response to the illegal/unpronounceable item, likj: (like, 34; link). In contrast, Table F in the Appendix shows a much broader spread of responses. In response to the legal nonsense word, delm, for example (#4), 35 Ss gave eleven different words. Not only are there more words which differ, the distribution of the responses generally is unlike the distributions found in Tables D and E. Tables 3 and 4 present a summary

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Tables 3 and 4 about here

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of a one-way analysis of variance with repeated measures and while there is virtually no difference in the responses to the two illegal types, the differences between either of these two illegal types and the legal types again is highly significant. ($F = 14.41$; $df = 2,44$, $p < .01$) Again, Scheffé tests were used to test for significance.

These results would seem to accord more with the findings of Baron (1973) whose conclusions would more favor a graphemic-encoding hypothesis. As Meyer, Schvaneveldt and Ruddy (1974) note in their assessment of Baron's work, "perhaps reading involves a 'pre-processing' stage that is influenced by graphemic structure, e.g., bigram and trigram frequencies ..."(Meyer et al, 1974:310). Perhaps some notion of frequency could be extended to support a case for a meaningful visual search which can end quickly when a nonsense item is judged to be a non-word on the basis of its being one or possibly two, real, quite frequent words that just happens to be recognized intact but for one gross--i.e., easily distinguished--orthographic violation. In reacting to Rubenstein et al's interpretation of their data, Meyer et al noted that:

> ...graphemic properties of the letter strings may have been confounded with phonemic properties. For example, it is possible that the unpronounceable nonwords looked least like English ... (Meyer et al, 1974:311).

The alternative interpretation offered in this paper is that of more consequence than the possibility that the unpronounceable non-words looked least like English is the possibility, rather, that these unpronounceable nonwords most resembled a limited number of very common English words, but for what very simply could be judged to be a minor graphic error--in the nature of a typographic error--a simple orthographic violation. Looking again to Tables D and

E in the Appendix, for all 35 Ss, ghosj was ghost, glazb was glaze, grovt was grove, and bravq was brave. With the exception of items #20 (drilt) and 22 (nosk) and possibly #14 (drifs), Table F provides a very different picture for the responses to the legal, easily pronounced nonsense words.

While not replicating latency experiments, and allowing for the different modes of presentation, it would appear that an explanation of adults' dealing with words in isolation is as traceable to a more directly, visual, semantic-based strategy as it might be to a phonological-based strategy. As Meyer et al (1974) note, however, Baron reminds us of the importance of the nature of task demands: "...the codes which help in recognizing printed words may depend on the type of task involved ...(319)." With reference to comprehension in remembering sentences, Barclay (1973) says much the same: "... task demands play a critical role in determining what sort of representations Ss construct (1973:252)." And so, while Meyer et al talk of presenting words "without biasing context" and acknowledge that different tasks make available to Ss different amounts of contexts (1974, 318-319), this writer would still press for an accommodation in any theory which purports to describe or explain recognition of printed words more than a little of what I take Bransford, Barclay and Franks (1972) to mean when they claim that "sentences (don't) carry meaning." People carry meanings, ... (1972, 207)." The implication seems clear that if one accepts that sentences don't carry meaning, words in isolation--particulary nonsense items--could be in even greater need of meaning, which, in turn presumably could be supplied by individuals who are asked to make lexical decisions.

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TABLE 1

Summary of Analysis of Variance for Pronunciability Ratings

Source	SS	df	MS	F
Among Lists	62565.08	2	31282.54	272.25*
Among Subject	18239.89	34	536.46	
Subj X Lists	7813.25	68	114.90	
Total	88618.22	104		

*p<.001

TABLE 2

Means and Standard Deviations for Pronunciability Ratings

	$\bar{X}_1$	$\bar{X}_2$	$\bar{X}_3$	SD
	95	86.17	39.37	
$\bar{X}_1$	-	8.83	55.63*	16.69
$\bar{X}_2$		-	46.80*	16.59
$\bar{X}_3$				14.55

*p <.01

TABLE 3

Summary of Analysis of Variance for One-Word Responses

Source	SS	df	MS	F
Among Lists	178.81	2	89.40	14.41*
Subjects	165.74	22	7.53	
Subj X Lists	273.21	44	6.20	
Total	617.76	68		

*p <.01

TABLE 4

Means and Standard Deviations for One-Word Responses

	$\bar{X}_1$	$\bar{X}_2$	$\bar{X}_3$	SD
	3.52	3.65	7.00	
$\bar{X}_1$	-	.13	3.48*	1.80
$\bar{X}_2$		-	3.35*	1.66
$\bar{X}_3$	-	-	-	3.72

*p <.01

TABLE A

Pronunciability Ratings for Nonsense Items

(Orthographically and phonologically illegal, unpronounceable)*

		Easy 1	2	3	4	Hard 5
1.	tritv		2	2	9	22
2.	tubw	1	1	3	12	18
3.	spitj	2		7	9	17
4.	stuml	1	6	7	14	7
5.	likj	1		5	12	17
6.	flipb	2		8	5	20
7.	rakv	2	1	8	8	16
8.	latv	2	4	11	8	10
9.	codg	3	2	12	10	8
10.	stagv	1	2	2	8	22
11.	safv		2	5	11	17
12.	crazj	1		7	5	22
13.	sagm		2	6	14	13
14.	barkv	1	2	7	10	15
15.	ghosj	1		4	9	21
16.	crafj	1		6	11	17
17.	stakg	1		5	7	21
18.	stagb	1	2	5	11	16
19.	crepw		2	3	9	21
20.	grunw			6	4	25
21.	scolr	2	3	5	11	14
22.	damr		2	8	9	16
23.	spitk	4	4	7	9	11

*As defined by Rubenstein, Lewis and Rubenstein (1971).

TABLE B

Pronunciability Ratings for Nonsense Items

(Orthographically and phonologically illegal, pronounceable)*

	Easy 1	2	3	4	Hard 5
1. fuzg	3	2	7	12	11
2. glazb		2	7	10	16
3. tufk		4	9	8	14
4. cresf	1	4	8	11	11
5. gratf	1	2	9	10	13
6. blaef		2	8	10	15
7. crudf		1	11	8	15
8. spokf	2	1	5	12	15
9. crepf	4	5	7	13	6
10. rudk	1	2	10	11	11
11. trucp			5	15	15
12. cravb		3	7	8	17
13. topk	3	3	10	11	8
14. railg	1	3	4	13	14
15. thonb		4	11	13	7
16. grovt	2	1	8	13	11
17. crabg		1	5	11	18
18. ratn		4	6	12	13
19. bravg	1	3	8	6	17
20. ponv	2	3	13	5	12
21. framk	9	11	9	5	1
22. winp	6	6	9	7	8
23. lamg	1	7	10	12	6

*As defined by Rubenstein, Lewis and Rubenstein (1971).

TABLE C

Pronunciability Ratings for Nonsense Items

(Orthographically and phonologically legal)*

		Easy 1	2	3	4	Hard 5
1.	drilk	14	10	5	4	2
2.	clefe	16	9	5	3	1
3.	melp	25	7	2	1	
4.	delm	19	8	6	2	
5.	losp	18	10	5	2	
6.	disp	22	9	2	1	1
7.	drep	27	6	2		
8.	tors	26	6	3		
9.	trife	23	6	4	2	
10.	fronk	19	6	7	2	1
11.	flet	31	3	1		
12.	pronk	19	7	6	2	1
13.	blesp	8	9	7	7	4
14.	drifs	17	11	2	5	
15.	bleg	24	8	3		
16.	nump	24	5	4	2	
17.	flan	27	7		1	
18.	jund	18	11	4	2	
19.	prot	24	7	3	1	
20.	drilt	20	7	6	2	
21.	frilt	16	8	3	6	2
22.	nosk	22	7	5	1	
23.	herv	16	8	6	4	1

*As defined by Rubenstein, Lewis and Rubenstein (1971).

TABLE D

One-word Responses to Nonsense Items

(Orthographically and phonologically illegal, unpronounceable)*

1.	tritv	trite (31); trivit (2); trick; trist
2.	tubw	tube (22); tubs (9); tub (4)
3.	spitj	spits (24); spite (8); spit (2); spirit
4.	stuml	stump (21); stumble (13); stuck
5.	likj	like (34); link
6.	flipb	flips (30); flip (4); flirt
7.	rakv	rake (34); rank
8.	latv	late (34); lave
9.	codg	code (28); cod (5) cogs (2)
10.	stagv	stage (31); stags (2); stag (2)
11.	safv	safe (32); save (2); safty
12.	crazj	crazy (34); craze
13.	sagm	sage (27); sag (5); sags (2); saga
14.	brakv	brake (31); brave (3); break
15.	ghosj	ghost (35)
16.	crafj	craft (32); crafty; crave; crazy
17.	stakg	stake (33); stag; stage
18.	stagb	stage (28); stag (4); stags (2); stab
19.	crepw	crept (20); creep (8); crepe (4); crew (2); crews
20.	grunw	grunt (24); groan (2); ground (2); grown (2); grump (2); green, grub, grüne
21.	scolr	scold (23); scholar (3); school (3); score (3); scale, scoll, scope
22.	damr	dame (15); damn (10); damp (6); dam (2); dams (2)
23.	spitk	spite (18); spits (9); spit (7); spike

*As defined by Rubenstein, Lewis and Rubenstein (1971).

TABLE E

One-word Responses to Nonsense Items

(Orthographically and phonologically illegal, pronounceable)*

1.	fuzg	fuzz (24); fuzzy (6); fuze (5)
2.	glazb	glaze (35)
3.	tufk	tuft (18); tuff (6); tusk (6); turf (3); tuck (2); turk; tough
4.	cresf	crest (34); cress
5.	gratf	grate (26); graft (7); grasp; grateful
6.	blaef	black (30); blast (2); blade, blat, bleach
7.	crudf	crude (33); crud, crust
8.	spokf	spoke (34); spoken
9.	crepf	crept (30); creep (3); crepe (2)
10.	rudk	rude (29); ruddy (2); red, runs, rusk, rut
11.	trucp	truce (21); truck (13); trust
12.	cravb	crave (30); crab (4); crabs
13.	topk	tops (25); top (5); topic (3); tock, took
14.	railg	rails (28); rail (5); railing, raise
15.	thonb	thumb (9); thong (9); throne (6); throne (6); throb (2); thin, tomb, snob
16.	grovt	grove (35)
17.	crabg	crabs (26); crab (8); crabby
18.	ratn	rat (24); rats (7); rat (4)
19.	bravg	brave (35)
20.	ponv	pony (25); pond (9); pong
21.	framk	frame (22); frank (13)
22.	winp	wind (20); wine (8); wins (4); win (2); wing
23.	lamg	lamb (15); lame (12); lamp (8)

*As defined by Rubenstein, Lewis and Rubenstein (1971).

TABLE F

One-word Responses to Nonsense Items

(Orthographically and phonologically legal)*

1.	drilk	drill (27); drink (7); drills
2.	clefe	cleft (29); cleff (3); clefs, cleve, clif
3.	melp	melt (30); help (3); kelp, meld
4.	delm	delt (6); helm (6); dell (5); delve (5); deli (4); deem (3); elm (2); delta, den, dent, desk
5.	losp	lost (24); lose (10); loose, wasp
6.	disp	dish (13); disk (12); disc (4); lisp (2); dip, dis, dise, disappear
7.	drep	drip (14); drop (4); dred (3); dreg (3); drape (2); dream (2); drap, dredge, drew, dress
8.	tors	tore (11); torn (9); torque (3); tort (3); ors, stories, tart, toast, tokes, toro, torso, tours, toys
9.	trife	trifle (11); trite (8); tribe (5); tripe (3); trip (3); tri, trick, trike, trist, rifle
10.	fronk	front (25); frank (5); frond (2); frock, from, frump
11.	flet	fleet (7); flit (6); flat (4); fled (4); flee (4); flew (3); flack, felt, phet, flea, flem, flip, velt
12.	pronk	prone (16); prank (7); prong (6); prod (2); pronto (2); pranks, prom
13.	blesp	bless (26); blest (8); bleep
14.	drifs	drift (32); drifts (2); drips
15.	bleg	bled (16); blew (4); beg (3); bleed (3); bless (3); blue (2); bleu, black, bleet, leg
16.	nump	numb (32); number; bump, hump
17.	flan	flap (7); flat (7); flag (6); flank (4); plan (2); fan, flab, flake, flame, flannel, flare, flip, Fran, land

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18.	jund	junk (19); jump (9); June (4); jungle, junta, join
19.	prot	prod (15); prop (7); probe (3); prom (3); prat, pro, pros, prone, protect, dot, pivot
20.	drilt	drill (34); drift
21.	frilt	frill (26); frills (3); frisk (2); fruit (2); fill, frost
22.	nosk	nose (34); noise
23.	herv	herb (18); hers (6); herd (4); here (3); her (2); hero, hurt

*As defined by Rubenstein, Lewis and Rubenstein (1971).